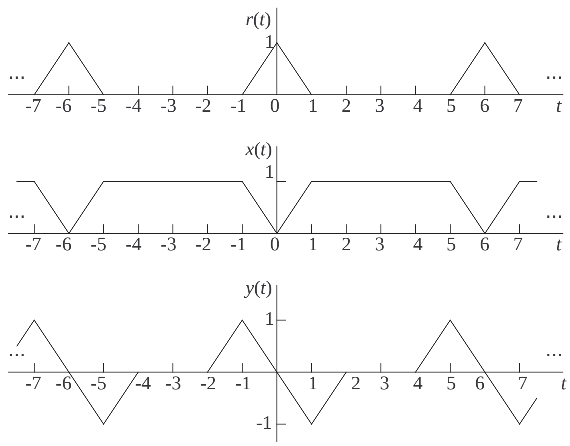
ENEE 222: FINAL EXAM REVIEW

2. All signals shown below are periodic and have complex Fourier series expansions of the form

$$s(t) = \sum_{k=-\infty}^{\infty} S_k e^{jk\Omega_0 t} ,$$

where Ω_0 is the fundamental angular frequency.



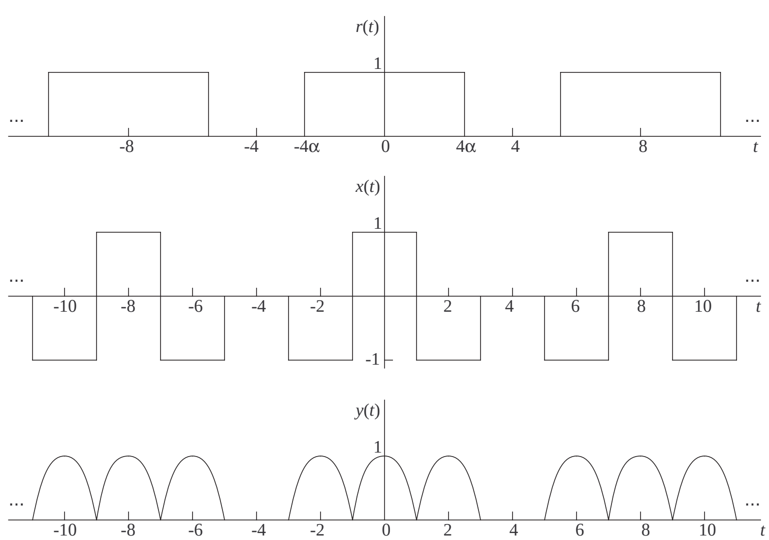
(i) Assuming that t is in seconds, what is the value of Ω_0?

(ii) Evaluate R_0.

(iii) Express each X_k in terms of R_k's.

(iv) Express each Y_k in terms of R_k's. Simplify your answer as much as possible.

3. All signals shown below are periodic with complex Fourier series as in Problem **2** above. The curved segments of $y(t)$ are sinusoidal.



(i) Using the fact that $R_k = \sin(k\alpha\pi)/(k\pi)$, obtain an expression for each X_k. You need not simplify your answer.

(ii) Express each Y_k in terms of X_k's.

4. A FIR filter has impulse response

$$h[n] = b_0\delta[n] + b_1\delta[n-1] + b_2\delta[n-2] + b_3\delta[n-3] + b_4\delta[n-4]$$

Its magnitude (amplitude) response is given by

$$|H(e^{j\omega})| = |\cos 2\omega - 2\cos\omega|$$

and its phase response is piecewise linear.

(i) Assuming that $b_0 > 0$, determine the values of $b_0, \dots, b_4$.

(ii) Determine the response of the filter to the input

$$x[n] = \left(\frac{2}{3}\right)^n, \qquad n \in \mathbf{Z}$$

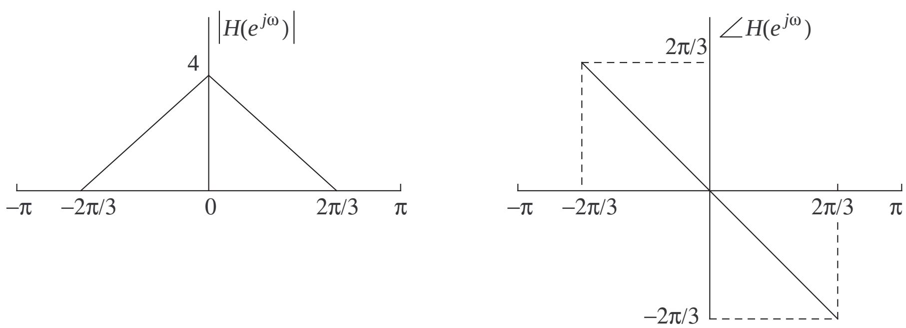
(iii) The phase response $\angle H(e^{j\omega})$ of the filter has exactly one discontinuity (jump) in the frequency interval $[0, \pi]$. At what value of ω does the discontinuity occur? Solve for ω algebraically (*not* graphically), using the identity $\cos 2\omega = 2\cos^2\omega - 1$.

5. Consider the signal sequence $\mathbf{x}$ defined by

$$x[n] = 3\cos\left(\frac{\pi n}{3} + \frac{2\pi}{5}\right) + 2\cos(2.75n - 1.24)\,, \qquad n \in \mathbf{Z}$$

(i) If $\mathbf{x}$ is the input to a filter with magnitude (amplitude) and phase responses as shown in figure below, determine the resulting output sequence $\mathbf{y}$.

(ii) Is the output $\mathbf{y}$ periodic, and if so, what is its period?



7. Two FIR filters whose impulse response sequences $\mathbf{h}^{(1)}$ and $\mathbf{h}^{(2)}$ are given by

$$h^{(1)}[n] = \delta[n] + \delta[n-1] + \delta[n-2] + \delta[n-3] + \delta[n-4]$$

and

$$h^{(2)}[n] = \delta[n] - \delta[n-1]$$

are connected in series (cascade) to form a single filter with impulse response $\mathbf{h}$.

(i) Using z-transforms or convolution, determine $h[n]$ for every n.

(ii) I claim that if the input to the cascade is a periodic sequence $\mathbf{x}$ of period $N = 5$, then the output sequence $\mathbf{y}$ is constant in value, i.e., $y[n] = c$ for all $n \in \mathbf{Z}$; and that, furthermore, the value c is the same for all periodic sequences of period $N = 5$.

Is my claim correct? If it is correct, what is the value of c? *Explain.*